BOSTON UNIVERSITY

College of Business Administration

THESIS

The Generation of Current vs the Wholesale Purchase of Current for Distribution and Sale by the Reading Municipal Light Board.

-by-

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CHAPTER I

INTRODUCTION

Problem Involved

The Town of Reading, Massachusetts, situated twelve miles north of Boston, is, primarily a residential town with a few small industrial plants. The present population is slightly over ten thousand and, by far, the majority of the working population is employed in Boston. The Town's affairs are still governed by the, more or less, old-fashioned medium of the Town Meeting.

It would be unfair, however, to give the impression that the town is backward or unprogressive, for just the opposite is true. Virtually all of its officials are high caliber men and women who serve without compensation. Its schools, police department, fire department and other municipal departments are at least as efficient as those of other fairly comparable communities. There is an unusual amount of local pride, when it is considered that most of those citizens gain their livlihood elsewhere.

Reading is bordered on the northwest by the town of Wilmington; on the north, by the Town of North Reading and on the northeast by the Town of Lynnfield. These are all small towns which were formerly agricultural, but now many of their residents are employed in nearly cities. None of these communities have any industries of significant size. The total population of the four towns is slightly under twenty thousand.

About forty years-ago the Town of Reading established a municipally owned electric light plant, equipped to generate and distribute sufficient current to meet the needs of the town at that time. As the town grew and the rates for electric current were gradually decreased, the demand for current quite naturally increased. The generating plant and distributing system were enlarged from time to time to keep pace with the increasing demand for current.

By 1925 the plant was not only serving its customers in the Town of Reading, but also customers in the Towns of Wilmington, North Reading and Lynnfield. In addition to serving commercial and residential customers in these four towns, it owned and furnished current for the street lighting equipment in all four of these communities.

While the generating plant was still able to produce sufficient current to take care of the peak load in 1925,

it did not have the capacity to meet any appreciable increase in the demand. Furthermore some of the generating equipment had been used so long that the end of its useful life seemed close at hand. It was feared that this old equipment would break down. Under the conditions this would have made it impossible to meet the normal demand for current, to say nothing of meeting the peak load demand. It is apparent that this condition could not have been allowed to exist indefinitely.

Following the recommendation of the Municipal Light Board, the Town of Reading decided, in March 1926, to purchase electric current in bulk from the Edison Electric Illuminating Company of Boston. This decision was not reached, however, until there had been several town meetings and one referendum vote on the matter.

It is the problem of this thesis to determine whether the final decision to purchase current at wholesale, rather than to continue to generate current as had been done quite successfully for approximately thirty years, was sound, in view of more recent developments. It is also intended to draw some conclusions as to whether or not it is best to continue the wholesale purchase of current in light of present conditions and in view of the probable future development of the four communities served by the Reading Municipal Light Plant.

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It is the problem of this thesis to determine whether the final decision to purchase current at wholesale, rather than to continue to generate current as had been done quite successfully for approximately thirty years, was sound, in view of more recent developments. It is also intended to draw some conclusions as to whether or not it is best to continue the wholesale purchase of current in light of present conditions and in view of the probable future development of the four communities served by the Reading Municipal Light Plant.

Significance of This Study

It will become apparent from further material to be presented that neither the Reading Municipal Light Board nor the voters of the Town of Reading came to any hasty conclusion when it was decided to depart from a long established policy of generating current. There was too much sentiment connected with development of the town's electric lighting plant and too much fear of domination from outside sources to permit any such result. The question was thoroughly debated at town meetings and on the street corners. It was studied by many voters.

It seems fair to conclude, however, that the question was so far-reaching, the subject so technical, and the time of most voters so limited, that the significant facts became somewhat befogged. For this reason a comprehensive review of the whole question at this time should be of considerable value. In light of the experience of the last ten years and in view of the outlook for the immediate future, a careful analysis of the facts may prove worthwhile regardless of the conclusions.

At this time it seems unlikely that the results of this study will ever come to the attention of the consumers of electricity or the voters of the town. Perhaps

the fact that a life-long resident of the town, who is actively interested in community affairs, has made a study of a matter so vitally important to the town, is sufficient reason for a thesis on this particular subject. Certainly, from the point of view of the writer an analysis of the question under discussion is of enough importance and interest to justify the time involved.

Resumé and Results of Previous Study

During the latter part of 1924 it became apparent that the generating plant would have to be enlarged at considerable cost or arrangements made to purchase current in bulk from some outside source. After making a careful study the Municipal Light Board recommended, at the annual Town Meeting in March 1925 that current be purchased at wholesale from the Edison Electric Illuminating Company of Boston. The light board had sufficient authority to decide the matter itself, but it was proposed to finance the building of certain conduit and other equipment by a bond issue. Even though the interest on the bonds as well as the funds to retire the bonds would have come from the revenue derived from the sale of current, it would have been necessary to have the credit of the town behind the

bonds if issued. This required a two-thirds vote of the voters present and voting at Town Meeting. For this reason, then, the whole question of whether to enlarge the existing generating plant or whether to purchase current at wholesale, was virtually placed before the town at its regular annual meeting in March 1925.

At this meeting it was voted, "that the Municipal Light Board be authorized to contract with the Edison Electric Illuminating Company of Boston for the purchase of electricity in bulk, said electricity to be furnished and delivered during a period of ten years, and to enlarge and extend the present plant by the construction of an underground transmission line from the Stoneham-Reading line to our power station on Ash Street, including transformers, switches, regulators and other necessary apparatus."* The vote also authorized the town treasurer to issue bonds for one hundred thousand dollars to run not more than twenty years. The proceeds from the sale of these bonds, together with such amounts as were available in the depreciation fund, were to be used under the direction of the Municipal Light Board for the above stated purpose. This vote was practically unanimous.

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*Annual Report--Town of Reading--1925-page 24.

The Town Meeting had hardly adjourned, however, before certain vigorous, and in some cases influential citizens, were loudly proclaiming that the town had "mortgaged its soul" to the Edison Company. Not that they thought that the Edison Company was so unholy in itself, but the idea of dealing with a "large corporation" was, to their minds, worse than falling into the clutches of a giant octopus!

It soon developed that this group was in ernest. They were not content, as is so often the case, to sponsor their case in the barber shops and on the local trains to Boston. They immediately went to work to get the required signatures to bring about a referendum vote. On March 31, 1925 the voters, or at least some of them, went to the polls to vote on the question of whether they were willing to affirm the action taken by those voters who were present at the regular annual Town Meeting held earlier in the same month. The result was that 529 voted not to affirm the previous action, while 436 voted to affirm the action taken at the Town Meeting.* This settled the question for the moment, but left the light plant in the same unsatisfactory condition, and the manager of the light plant hoping that the ancient equipment would continue to function until the voters could

*Annual Report--Town of Reading--1925-page 27.

come to some decision as to what they really did want to have done.

From the heated arguments that were heard about town and the long articles on both sides of the question which were published in the local paper, it would have appeared that when the town next voted on the "light question," no hall in town would have been big enough to hold the voters who would be anxious to help determine the fate of the light plant. Such was not the case, however, for when the question was again brought before the voters at a special Town Meeting in May of 1925 only 440 votes were recorded.* 274 voters were in favor of purchasing electricity in bulk from the Edison Electric Illiminating Company of Boston and 160 were opposed. Inasmuch as a two-thirds vote was required to carry the motion, it was lost. The situation was still as unsatisfactory as when the question was first presented to the Town Meeting in March.

At another special Town Meeting of June 8, 1925 the issue became even more involved. It was impossible to get the necessary two-thirds vote to authorize the light board to expand the plant and thus provide for the generation of current in sufficient quantity to meet the existing demand. At this same meeting the town voted to

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At another special Town Meeting of June 29, 1925 the issue became even more involved. It was impossible to get the necessary two-thirds vote to authorize the light board to expand the plant and thus provide for the generation of current in sufficient quantity to meet the existing demand. At this same meeting the town voted to

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indefinitely postpone any action making possible the purchase of current in bulk from the Edison Electric Illuminating Company of Boston.*

During the summer months the situation was again thoroughly discussed on the street corners and in the local press. Many of the consumers of electricity had now reached the point where they were hopelessly confused as to what was the best thing to do, but they were pretty generally agreed that it was high time something should be done before their service was seriously interrupted. As the days began to grow shorter the necessity of reaching some solution appeared more and more urgent. It seemed that many voters would be glad to favor most any scheme that would assure action rather than continue discussion.

In September it became necessary to call another special Town Meeting to consider several matters and again the "light question" was introduced.** At this meeting an attempt was made to have the town authorize the light board to purchase electricity in bulk without specifically naming any company with which the purchase contract should be executed. After this plan had been turned down, a motion was made which would have authorized the light board to enlarge the existing plant. It was

* Annual Report--Town of Reading--1925-page 27.
**Annual Report--Town of Reading--1925-page 35.

not possible to muster the necessary two-thirds vote to carry this motion. The Town Meeting adjourned once more after heated arguments, but without any solution of the problem.

On October 26, 1925 another special Town Meeting was held. Again the voters refused to authorize the light board to extend and enlarge the generating plant. It was, however, finally voted at this meeting, "that the Municipal Light Board be, and they hereby are, authorized to contract in behalf of the Town by and with the Eastern Massachusetts Electric Company, for the purchase of electricity in bulk for a period not exceeding ten years, upon such terms and conditions as, in the opinion of the said Board, will be for the best interests of the town."*

It was generally considered that the matter had been settled, as far as the voters were concerned. It is doubtful, however, if the action at the meeting on October 26 was so worded that any funds necessary to carry out the project could have been raised through the sale of bonds. This question was never brought up, however, as the light board was not able to secure a contract from the Eastern Massachusetts Electric

*Annual Report--Town of Reading--1925-page 37.

Company that it felt justified in executing. This development in the situation soon became known throughout the town and the question of whether "to generate or not to generate" was once more the subject of heated discussion. No other plan came officially before the Town until the regular Town Meeting on March 8, 1926.

At this meeting the light board made the following report:

"The question of electric light has confused the minds of the voters until they do not know what is best. This question has been discussed for more than a year and has been before the voters in one way or another until it has seemed as though it never would be settled. I am going to say very little about what happened previous to my appointment to the Board last December. The Electric Light Commissioners in 1924 made a study of the question and recommended the purchase of electric current from the Edison Company with a contract for ten years and an outlay of $100,000.00 for conduit and cables. There were some who thought it unwise to sign a ten-year contract and were opposed to expending $100,000.00. There were others who wanted to continue to generate at any expense.

"On October 26th last the Town passed the following vote:

> 'That the Municipal Light Board be, and they are hereby authorized to contract in behalf of the Town with the Eastern Massachusetts Electric Company for the purchase of electricity in bulk for a period not exceeding ten years upon terms and conditions as in the opinion of said Board will be for the best interests of the Town.'

"The Board asked for and received a contract from the Eastern Massachusetts Electric Company December 7th, which contract they had printed in the Reading Chronicle so that the voters could have an opportunity to study it. They thought it unfair to bind the Town by signing such a contract and have since been striving to find some way that this question could be settled to satisfy everyone and to the best interests of the Town.

"After careful consideration, the Board has concluded that the last offer received from the Edison Company would be for the best interests of the Town.

"The Company offers to construct, at its own expense, a four-duct underground conduit with two 5000 K. V. A. cables from the Stoneham line to our power station, and connect with our switchboard at 2300 volts, ready for

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"The Company offers to construct, at its own expense, a four-duct underground conduit with two 5000 K. V. A. cables from the Stoneham line to our power station, and connect with our switchboard at 2300 volts, ready for distribution by us.

"We are to pay for the use of the property installed by the Company in Reading an annual rental equal to 13½ cents on the cost, which cost is estimated at $85,728.00. This is practically the same amount which we would pay for fixed charges if the Town made the investment.

"The Company will maintain all the equipment which it furnishes. The Town is to have the right at any time within ten years to take over the property owned by the Company upon payment of its cost less depreciation.

"The locations for the line to be granted jointly to the Town and the Company if the Board so desires, and stipulation in the grant of locations that the Company will not sell electricity to anyone in our territory unless ordered to do so by public authority. No term contract will be required, and the Town may terminate the service at any time upon ten days notice. The rate is the wholesale co-operative rate, which is the lowest rate we have been offered.

"I am going to ask Mr. Sias to go more fully into the details of the proposed contracts and give you any other information you may desire.

"It is the policy of this Board to give to the voters all the information which we have and will

welcome any suggestions which you may have that may assist us in giving service or reduce cost.

"I believe that those persons who have participated in this discussion have been working as they saw fit for the best interests of the Town.

"Let us get together on this question and watch the results. You can plainly see you have nothing to lose. Your plant will be undisturbed, your money unexpended, no contract, and you will be just as free in one, two, or three years to go on generating if the results are not satisfactory."*

Following this report it was voted "that it is the sense of this meeting that the Municipal Light Board be authorized to procure a supply of electric current in accordance with the plan just outlined by the chairman of the Board"

Purpose of This Study

An indirect result of this thesis will be to conclude whether the Town of Reading acted wisely when it finally decided to purchase electric current in bulk, rather than to continue the generation of current at its own plant.

*Town of Reading--Annual Report for 1926-page 22.

The main purpose of this study, however, is to draw some conclusions and to make specific recommendations as to the advisibility of the Town continuing to purchase electricity in bulk in view of the probable developments in the communities served by the Reading Light Plant.

Method of Approach

In making this study it is intended to discuss first the problem of "valuation" for rate making by a municipal electric light board, in order to determine which of several possible methods of valuation is the most sound.

A resumé of the present situation will then be made as well as a study of the outlook for future consumption of electricity in each of the towns served by the Reading Light Plant.

With the results of this study as a basis, it is intended to determine the capacity, cost, and operating expense of a generating and distributing system, adequate to meet the present demand with a safe margin for future development.

If this information can be determined with a fair degree of accuracy, it will be possible to develop a rate schedule which might be used if the Reading Light

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If this information can be determined with a fair degree of accuracy, it will be possible to develop a rate schedule which might be used if the Reading Light

Board were to generate its own electricity. The present rate schedule, based upon the wholesale purchase of current, will be reviewed and if it seems that changes should be made they will be suggested.

The rate schedule based upon the generation of current will be compared with that recommended, on the assumption that the purchase of electricity in bulk is to continue. This will show clearly which plan should be more advantageous to the consumers of electric current. It is intended to also consider certain factors of a more general nature, such as the interests of the tax payers and the disadvantages of dependency on outside sources for current.

From a consideration of all of these various factors, the final conclusions will be reached.

CHAPTER II

VALUATION FOR RATE MAKING
BY
A MUNICIPAL ELECTRIC LIGHT BOARD.

General Considerations

The various problems which arise in connection with rate making by a municipal light board are not essentially different than those that confront the managers of electric companies owned by private capital. In both cases the rate schedules, and consequently the valuation used as a basis for these schedules, are subject to review and approval by the designated state authorities. It is an accepted principle that the stockholders of privately owned public utilities are entitled to a fair return on their investment. What constitutes a reasonable return is a question that has not been answered by legislation in respect to public utilities privately owned.

In Massachusetts, however, legislation has been more specific in regard to profits of municipal electric and gas companies. Section 58, chapter 164 of the

Massachusetts General Laws of 1932 provides that rate schedules of such companies must be fixed so that the profits will not be in excess of eight per cent per annum on the cost of the plant as determined by the Department of Public Utilities.

It is, therefore, apparent that determining the "cost of the plant" is of primary importance in rate making by municipal light boards. Before discussing in detail the various methods that may be used to evaluate the amount invested in the plant, it will be well to consider the general objectives of rate schedules.

It is essential that the rates be high enough to preserve and protect the plant investment. The income must not only be sufficient to cover the operating costs, but it must be large enough to insure adequate maintenance of the generating equipment and destributing systems; and also to allow payments to the depreciation fund. If the investment in the plant is not protected in this way the time will eventually come when large expenditures will be necessary in order to make replacements and extensive repairs and the funds will not be available except as a result of borrowing. Rates which have not been high enough to protect the plant investment will, of course not be high enough to absorb the increased

costs brought about by borrowing. This will mean that rates will have to be increased. Over a period of time, failure to consider the necessity of preserving and protecting the investment when rates are established, will cause an unjustifiable fluctuation in rates.

On the other hand, if proper consideration is given to the need for adequate maintenance and the building up of a depreciation fund, the cost of the plant will be distributed over its life. This levelling out process will help to prevent rate fluctuation except as brought about by other factors.

Not only should the rates provide sufficient income to preserve and protect the investment, but, they should provide earings large enough to cover all of the operating costs. Otherwise, of cource, there will be no profits. This point is not likely to be overlooked when rates are established, but in order that reliable information may be available when rates are set it is paramount that complete and adequate financial records be kept.

In addition to these two factors, allowances should be made for growth and expansion. Reserves should be established from income in order that, at least part of the funds required for expansion necessary to meet the increased demand for current, will be available. If all the funds needed for expansion have to be borrowed, it costs brought about by borrowing. This will mean that rates will have to be increased. Over a period of time, failure to consider the necessity of preserving and protecting the investment when rates are established, will cause an unjustifiable fluctuation in rates.

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In addition to these two factors, allowances should be made for growth and expansion. Reserves should be established from income in order that, at least part of the funds required for expansion necessary to meet the increased demand for current, will be available. If all the funds needed for expansion have to be borrowed, it is probable that the carrying charges will prove too burdensome, and rate fluctuations are likely to occur, as previously explained.

Before the rates can be established it will be necessary to consider, not only the foregoing elements, but also to decide how large a net return on the investment is desired. It will, of course, be impossible to predetermine the operating costs and operating income with exactness and, therefore equally impossible to accurately estimate in advance the net income. A fairly accurate estimate can, however, be made. A municipal electric light board must establish its rates so that the estimated net profit will not exceed eight per cent per annum, which is the maximum allowed under the Massachusetts Law.

There is another factor which should be considered before rates are finally fixed. They should be so made as to encourage the maximum use of the facilities of the plant in order to keep the production cost per kilowatt hour as low as possible. As many of the operating costs are virtually fixed the unit cost of production is increased as the output falls below the maximum. Furthermore, inasmuch as it is not possible to store electricity, the generating plant must be equipped to produce enough current to supply the peak demand. The nearer the average is probable that the carrying charges will prove too burdensome, and rate fluctuations are likely to occur, as previously explained.

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To summarize, then, the general objectives to be considered when rates for electric current are made are; to preserve and protect the investment; to cover cost of operation; to allow for growth and expansion; to give a fair return on the investment; and to encourage the maximum use of the facilities.

Methods of Valuation

There are various methods used in determining the value of an electric light plant as a basis for making rates that will meet the requirements just outlined.

One method is to value the plant at cost. It is probably less difficult to value an electric light plant load comes to the peak load the lower the cost in terms of kilowatt hour production. It is, therefore necessary to make rates for different classes of customers so that the demand throughout a twenty-four hour day will be as steady as possible. Even if the rates are established with this idea in mind, there are bound to be times during a span of twenty-four hours when the peak load will be well above the average load, but the unit cost of production can be lowered and hence the profit increased if adequate consideration is given to this feature when rates are established.

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One method is to value the plant at cost. It is probably less difficult to value an electric light plant under this method than under any of the other methods commonly used. If the plant is purchased there can be little doubt as to its cost. Municipal Light plants are not ordinarily purchased, however, but are usually constructed by or for the municipality. It then becomes a question of just what should be included in the cost.

It is generally considered that the cost of land should include the purchase price, broker's commissions, fees for examining and recording the title, taxes accrued at the time of purchase, and the cost of such improvements as grading, sewers, and pavements.

The cost of buildings includes the material and the labor or the contract price and many incidentals some of which are as follows:

1. Cost of permits and licences.
2. Cost of temporary buildings used for construction offices or tool sheds.
3. Architects fees and cost of superintendence.
4. All expenses incurred during the construction period, such as insurance and taxes.
5. Bond interest accruing during the construction period as well as the proportion of any bond discount applicable to the period of construction.

The cost of the distributing system would include not only the cost of the materials and labor, but any of

the items mentioned above which were applicable in a given instance.

It is apparent from the foregoing that while the computation of the value of a new plant is not particularly difficult it requires very careful consideration. If the plant has been in existance for a number of years, the problem of determining the cost becomes somewhat more difficult and the principles to be followed subject to greater differences of opinion, due to the fact that there usually have been extensions and replacements of the original equipment. Briefly stated, the problem is to distinguish between capital and revenue expenditures. There is hardly time here to discuss this distinction, but the generally accepted accounting principles should be followed with such alterations as may be necessitated by rulings of the State regulatory body. While this method of plant valuation for rate making purposes is probably not the most logical it does have the advantage of relative simplicity.

Instead of using the original cost, the depreciated cost of the plant may be used as a basis for rate making. If this is done the procedure is to determine the original cost of the plant and then deduct the estimated depreciation, thus arriving at what is known as the depreciated cost value. In determining the

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Instead of using the original cost, the depreciated cost of the plant may be used as a basis for rate making. If this is done the procedure is to determine the original cost of the plant and then deduct the estimated depreciation, thus arriving at what is known as the depreciated cost value. In determining the depreciated cost value the same problems are encountered in finding the original cost as previously mentioned, and in addition it is necessary to estimate the useful life of the buildings and equipment; the cost of removal and the scrap value, if any. With these factors determined it is possible to estimate the total amount to be charged as depreciation during the life of the assets. It then becomes necessary to decide which one of several methods should be used in computing the accumulated depreciation at the particular time when the depreciated cost is being determined. The soundness of this method of plant valuation would seem to depend almost entirely upon the accuracy of the several estimates which have to be made.

The underlying theory of reproduction cost as a basis for evaluating an electric light plant, calls for a determination of the cost of reproducing the identical property in use. After the proper amount of depreciation has been deducted from this cost of reproduction, the resulting value is used as the basis for determining what constitutes a fair return. Furthermore, it is assumed that the reproduction cost should include, not only the cost of replacing the identical physical property, but that it should also include all of the costs incidental to the raising of the necessary funds, of training the

required personal, of franchises, of legal services, educating the public in the use of the service, and any other expenses necessary to develop the business to the point that has already been reached by the existing company.

It is often very difficult to reach any satisfactory conclusion on this basis, because many times it results in an attempt to compute the cost of reproducing things that could not be reproduced. For example, it may well be that some of the equipment in use is obsolete and identical equipment could not be purchased. Oviously it is highly theoretical to try to find the cost of purchasing equipment that cannot be bought. Then, on the other hand, there are so many factors and so much detail involved that reasonable conclusions are almost impossible.

In this method of valuation it is usually contended that consideration should also be given to "going concern value". While it is entirely possible that different engineers or accountants may be somewhat in agreement as to the reproduction cost of the tangible assets it is very unlikely that representatives of different interests will come to any close agreement as to the allowance that should be made for the intangible item called "going concern value." In fact it is fairly apparent that any

attempt to evaluate an intangible of this nature, may lead to imaginative values, if not to deliberate misrepresentation.

Perhaps the reproduction cost method of valuation is theoretically sound, but its inherent weaknesses make it rather unsound from a practical point of view.

The difficulty arising from the more or less constant fluctuations in the purchasing power of the dollar is probably the reason that the reproduction cost method is frequently advocated and is the strongest arguement in its favor. Inasmuch as electric plants are expanding from time to time, it is necessary to make fairly frequent changes in the rate base. Changes are also necessary because price levels are not stable and costs of raising funds are not constant. It is therefore, desirable to find some method of evaluation that is relatively easy to use and that makes it possible to reach conclusions within a reasonable length of time. None of the foregoing methods fully meets these requirements.

"The most widely accepted alternative to reproduction costs new is the prudent investment method of fixing fair value. Its proponents maintain that it is fairer to all parties in the long run, that it meets the requirements of expediency, and that it is many times

easier to administer. What is more, the familiar appeal to authority may be made in support of this method, whether it be the authority of experience (Massachusetts and California), of legal provission (Federal power Commission), or of judicial dissents (Justices Brandeis and Holmes).

"Prudent investment designates the capital invested according to sound and honest judgment, that is, not wastefully and not dishonestly. Prudence is assumed unless imprudence is proved. In this respect prudent investment may differ from actual or original costs. It is upon the capital devoted to public use, not upon the property, that a return is to be paid the investor. If this distinction were accepted there would be no call for costly appraisals of obsolete or obsolescent property to determine present day costs.

"Within the valuation of existing properties once in hand the regulatory body would simply add the amounts of new money invested as such money is spent, providing for depreciation and obsolescence under approved rules. Thus the rate base always would be up to date and currently available for computing the rate of return and determining rates."*

The prudent investment theory seems to the writer

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*"Public Utility Regulation," Moshery Crawford--Harper Brothers--1933-pages 214 & 216.

to be the most satisfactory of any of the methods herein discussed because it furnishes a stable rate base, is easy to administer, and enhances the raising of funds.

CHAPTER III

THE PRESENT SITUATION

The Reading Municipal Plant comprises a generating station located in Reading together with a transmission and distributing system in the Towns of Reading, Wilmington, North Reading and Lynnfield. The street lighting equipment in these four towns is owned by the light plant rather than by the towns themselves. The plant also includes a garage in Reading, but the retail stores, operated by the light board in Reading and Wilmington, are in leased property. The business office is in the same building as the Reading store.

Generating Plant

Since the Town voted in 1926 to authorize the Reading Municipal Light Board to purchase current at wholesale from the Edison Electric Illuminating Company of Boston, virtually all of the current sold to consumers has been purchased from the Edison Company. Even though the Reading plant has not generated any current for the past four years, the generating equipment, that was owned at the time it was decided to purchase current at whole-

sale rather than to enlarge the plant, has been kept in good operating condition, so that it may be used for auxiliary service during periods of the year when there is an unusually heavy demand or in cases of emergency.

The latest available figures showing the investment in the generating plant are contained in the annual report of the Municipal Light Board for the year ended December 31, 1934. According to this report* the generating plant investment was $68,850.33 and included the following items:

Land	$ 2,575.80
Structures	18,697.72
Boiler Plant Equipment	11,161.46
Prime Movers and Auxiliaries	4,682.15
Turbo Generator Units	6,845.98
Electric Plant-Steam	24,887.22
Total	$68,850.33

Transmission and Distributing System

Expressed in mileage, the largest part of the distributing equipment consists of overhead conductors, although in Reading, near the center of the Town, there is some underground conduit carrying current to the street lights and stores. Some of the conductors in the same location are also underground.

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*Reading Municipal Light Board Annual Report-1934-page 253.

The 1934 report* showed the following investment in the distributing and transmission system.

Transmission Station and Substations	$ 484.30
Poles, Fixtures and Overhead Conductors	421,031.65
Underground Conduit	48,181.03
Underground Conductors	42,374.39
Consumers' Meters	34,979.91
Installations	7,592.91
Line Transformers	37,787.93
Line Transformers Installations	4,211.48
Street Light Equipment	16,701.87
Consumers' Premises Equipment	38.13
Total	$433,350.21

General Equipment

The business office of the Reading Municipal Light Board is located in a leased building on the edge of the shopping district in Reading. One of the retail stores operated by the Board is in this same building and the other store is near the center of Wilmington. In addition to the store and office equipment, the general equipment includes the automobiles used by the salesmen and service men employed in connection with the retail stores, as well as laboratory equipment and certain general equipment, as indicated by the following figures taken from the 1934 report.**

Office Equipment	$7,420.25
Store Equipment	584.14
Transportation Equipment	1,800.00
Laboratory Equipment	2,367.89
Miscellaneous Equipment	1,378.98
Total	$13,515.26

* Reading Municipal Light Board Annual Report-1934-page 254.
**Reading Municipal Light Board Annual Report-1934-page 254.

Besides the investment in the generating plant and the transmission and distributing system the 1934 report* includes an item of $14,214.10 as the amount invested in a garage. While this is included in the report as a part of the plant investment, it has been eliminated here from the generating plant investment. This same report** also includes an item called "Unfinished Construction" listed at $2,076.53.

A summary of the above figures will show that the total plant investment amounts to $532,006.43 as follows:

Generating Plant..........................	$ 68,850.33
Transmission and Distributing System....	433,350.21
General Equipment.........................	13,515.26
Garage....................................	14,214.10
Unfinished Construction...................	2,076.53
Total Investment	$532,006.43

Total Cost of Plant

The figures above show the investment, but in order to give a complete picture, it seems advisable to also include the cost of the plant as at December 31,1934.

Total Cost of Plant*** as at December 31, 1934.

Land..................................	$ 2,575.80
Structures............................	44,644.60
Total	$ 47,220.40

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* Reading Municipal Light Board Annual Report-1934-p.253.
** Reading Municipal Light Board Annual Report-1934-p.254.
*** Reading Municipal Light Board Annual Report-1934-p.254.

Generating Plant-Steam:	
Boiler Plant Equipment	$ 69,696.71
Prime Movers and Auxiliaries	29,013.38
Turbo Generator Units	46,870.83
Electric Plant-Steam	58,480.20
Total	$204,061.12

Transmission, Distribution, and Storage:	
Transformer Station and Substation Equipment	$ 484.30
Poles, Fixtures, and Overhead Conductors	407,541.22
Underground Conduits	50,497.13
Underground Conductors	44,238.59
Consumers Meters	62,089.98
Consumers Meters Installation	12,292.43
Line Transformers	61,417.92
Transformer Installation	6,824.21
Total	$645,385.78

Utilization Equipment:	
Street Lighting Equipment	$ 38,367.91
Consumers' Premises Equipment	428.99
Total	$ 38,796.90

Total Cost of Electric Plant as Shown by Books	$935,464.20

Cost of Distributing System in Outside Towns*

North Reading

Total Investment December 31, 1934:	
Poles, Fixtures and Overhead Conductors	$ 82,614.36
Consumers' Meters	11,259.80
Line Transformers	8,306.74
Street Lighting Equipment	3,019.07
Total	$105,199.97

Lynnfield

Total Investment December 31, 1934.	
Poles, Fixtures and Overhead Conductors	$ 35,948.66
Consumers' Meters	5,652.75

*Reading Municipal Light Board Annual Report-1934-page 255.

Line Transformers	$ 2,857.22
Street Lighting Equipment	1,839.75
Total	$ 46,298.38

Wilmington

Total Investment December 31, 1934:	
Poles, Fixtures and Overhead Conductors	$125,312.01
Consumers' Meters	16,603.65
Line Transformers	9,971.24
Street Lighting Equipment	4,329.89
Total	$156,216.80

Total Investments--Outside Towns	$307,715.15

Wholesale Purchase of Current

Although the vote of the Town authorizing the purchase of current from the Edison Electric Illuminating Company of Boston was passed in March 1926, the arrangements and necessary construction of underground transmission lines were not completed in time to allow the purchase of more than a relatively small amount of current during that year. In the next year, 1927, most of the current distributed by the Reading plant was bought at wholesale from the Edison Company. Since 1927, with the exception of 1929, all of the current sold by the Reading plant has been purchased from the Edison Company.

The following table shows the kilowatt hours generated and purchased from 1926 to and including 1934.*

*Reading Municipal Light Board Annual Report-1934-page 258.

Kilowatt Hours Delivered at Switchboard.

Year	K. W. H. Generated	K. W. H. Purchased
1926	3,600,580	819,787
1927	406,693	4,396,397
1928	none	5,097,768
1929	103,985	6,362,853
1930	none	7,050,708
1931	none	6,885,880
1932	none	7,324,775
1933	none	7,213,269
1934	none	7,516,389

In order to show more completely the situation which exists, as far as the wholesale purchase of current is concerned, the following table, indicating the average cost per kilowatt hour of current purchased, from 1928 to 1934, has been prepared.

Average Cost per Kilowatt Hour of Current Purchased.*

Year	Cost (in cents)
1928	1.227
1929	1.051
1930	1.106
1931	1.134
1932	1.1077
1933	1.0964
1934	1.121

Although a relatively small amount of current was purchased in 1926 and a substantial amount in 1927, the average cost per kilowatt hour purchased has not been included in the above table, as the necessary information

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*Reading Municipal Light Board Annual Reports-1928 to 1934.

to arrive at an accurate average for these years is not available. While the average cost in 1934 increased about 2.2 per cent over the average cost in 1933, a comparison of the 1934 figure with that of 1928 shows a decrease in the average cost of approximately 8.6 per cent.

The lowest average cost was in 1929 which shows a decrease of about 14.3 per cent as compared with the previous year. The average total production cost in 1929, including all labor and expenses, based on the kilowatt hours delivered at the switchboard was 1.349 cents as compared with 1.622 cents the previous year,* a reduction of nearly 17 per cent and was the lowest cost in the history of the plant.

Even though the average cost per kilowatt hour of current purchased in 1934 was greater than in 1929, the average total production cost per kilowatt hour delivered at the switchboard was lower than in any year when the Reading plant generated its own current.** It is, of course, not fair to conclude that this lower cost was necessarily due solely to the fact that the current was purchased rather than generated, because there were other factors entering into the situation. Nevertheless, the fact remains, that the situation is not as bad as those,

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* Reading Municipal Light Board Annual Report-1934.

** Reading Municipal Light Board Annual Report-1934-p 259.

to arrive at an accurate average for these years is not available. While the average cost in 1934 increased about 1.2 per cent over the average cost in 1933, a comparison of the 1934 figure with that of 1928 shows a decrease in the average cost of approximately 8.6 per cent.

The lowest average cost was in 1929 which shows a decrease of about 14.6 per cent as compared with the previous year. The average total production cost in 1929, including all labor and expenses, based on the kilowatt hours delivered at the switchboard was 1.540 cents as compared with 1.852 cents the previous year,* a reduction of nearly 17 per cent and was the lowest cost in the history of the plant.

Even though the average cost per kilowatt hour of current purchased in 1934 was greater than in 1929, the average total production cost per kilowatt hour delivered at the switchboard was lower than in any year when the Reading plant generated its own current.** It is, of course, not fair to conclude that this lower cost was necessarily due solely to the fact that the current was purchased rather than generated, because there were other factors entering into the situation. Nevertheless, the fact remains, that the situation is not as bad as those,

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[*] Reading Municipal Light Board Annual Report-1929.
[**] Reading Municipal Light Board Annual Report-1934-p 23.

who were opposed to wholesale purchase in 1925, feared. In fact, the consumer rates in 1934 were the lowest in the history of the plant. Whether they would have been as low if the current had been generated locally, still remains to be shown.

Consumption of Current by Towns

Inasmuch as the community served by the Reading Municipal Light Plant is largely residential the majority of its customers have residence service. Most of the customers that have commercial service should be classed as retail stores, rather than as industrial plants.

Of the 5,626 customers served by the plant in 1934, 4,874 or about 86.6 per cent, had residence service. In the same year there were 682 customers, or approximately 12 per cent, who had commercial service. The remaining 2 per cent were distributed over the various other classes of services offered by the plant.*

The following tabulation shows how the residential and commercial customers are distributed among the communities served.*

Town	Resident Service	Per Cent	Commercial Service	Per Cent	Total
Reading	2646	54.3	183	38.9	2829
Wilmington	1120	22.9	159	33.6	1279
No. Reading	700	14.4	93	19.7	793
Lynnfield	408	8.4	37	7.8	445
Total	4874	100.0	472	100.0	5346

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*Reading Municipal Light Board Annual Report-1934-p.251.

The per centage distribution of the resident service among the towns served is about as one familiar with these communities would expect and is closely correlated with population distribution.

While the essential facts as to the distribution of the more important classes of customers are shown by the table above, a complete classification of customers by towns is given below in order to round out the picture.

Classification of Customers as of December 31, 1934.*

Class of Service	Total	Reading	Wilmington	North Reading	Lynnfield.
Residence	4874	2646	1120	700	408
Commercial Miscellaneous	108	51	28	21	8
Lighting	458	272	106	56	24
Power	116	70	25	16	5
Municipal Miscellaneous	1	1			
Municipal Lighting	34	34			
Municipal Power	11	11			
Co-op. Resale	14	8	4	1	1
Pv. St. Lights	7	1	1	5	
Pub. St. Lights	3		1	1	1
Total	5626	3094	1285	800	447

As the rate schedules are not uniform for the four towns the distribution of customers is not indicative of the income received from these communities, nor does this customer distribution show the amount of current sold in the different towns. It, therefore, seems advisable to

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*Reading Municipal Light Board Annual Report-1934-p. 251.

include this additional information below.

Kilowatt Hours Sold and Income Received from Each Town in 1934*

Town	K. W. H. sold	Income
Reading	4,575,383	$163,282.27
Wilmington	951,360	51,530.66
North Reading	639,882	31,486.99
Lynnfield	337,169	17,853.96
Others	18,403	581.44
Total	6,522,197	$264,735.32

Present Rate Schedules**

The present rate schedule became effective on January 1, 1934 and is somewhat different for customers in Reading than for customers in Wilmington, North Reading, and Lynnfield; due, of course, to the fact that the plant is owned by the Town of Reading.

Following are the rates that apply in Reading for the various types of services offered:

Schedule A Residence Rates

Available for all uses in a single private dwelling or single apartment.

6¢ per KWH for the first 50 KWH per month
3¢ per KWH for the next 150 KWH per month
2¢ per KWH for all over 200 KWH per month

Schedule B Commercial Lighting Rates

Available for individual stores, offices, churches, halls, clubs and all individual places of business.

6¢ per KWH for the first 100 KWH per month
5¢ per KWH for the next 400 KWH per month
4¢ per KWH for all over 500 KWH per month

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* Reading Municipal Light Board Annual Report-1934-p.251.
**As published by Reading Municipal Light Board.

Schedule C Miscellaneous Commercial Rates

Available for charging storage batteries, cooking, heating, refrigeration and the operation of traffic signals.

6¢ per KWH for the first 25 KWH per month
3¢ per KWH for the next 375 KWH per month
2¢ per KWH for all over 400 KWH per month

Schedules A, B, and C carry a minimum charge of $9.00 per year except for customers who retain service for six months or less when the minimum charge is $4.50 for the period that the service is connected. If the minimum charge applies the customers accounts are adjusted on the last billing date of the calendar year.

Schedule D Commercial Power Rates

Available for motors and all other uses except lighting.

6¢ per KWH for the first 100 KWH per month
5¢ per KWH for the next 400 KWH per month
4¢ per KWH for the next 1000 KWH per month
3¢ per KWH for the next 3000 KWH per month
2½¢per KWH for the next 6000 KWH per month
2¢ per KWH for all over 10,500 KWH per month

The minimum monthly charge under this schedule is 50 cents per horse power of connected load, but in no case is it less than $1.00.

Schedule E Primary Power Rates

Available for motors, lights, heating and cooking apparatus and general use where the total connected load is not less than 100 K.V.A. and the connected lighting load does not exceed one third of the total connected load. Customers must provide the necessary transformers

and the current is metered on the primary side.

First 30 hours use per month of maximum kilowatt demand 3¢ per KWH.

Next 120 hours use per month of maximum kilowatt demand 2¢ per KWH.

Over 50 hours use per month of maximum kilowatt demand 1.9¢ per KWH.

The minimum charge under this schedule is $120 per year.

Schedule F Private Street Lighting Rates

Available for fire alarm lights and street lighting on private or unaccepted streets, or private property, when the pole lines of the Department are reasonably near, and pole locations can be obtained.

Rating of Lamp		Yearly Rates
60 C.P. Series or	50 Watt Multiple	$15.00
100 C.P. Series or	75 Watt Multiple	21.00
250 C.P. Series or	150 Watt Multiple	36.00
400 C.P. Series or	200 Watt Multiple	48.00
600 C.P. Series or	300 Watt Multiple	60.00
1000 C.P. Series or	500 Watt Multiple	72.00

Bills for this service are rendered monthly on a prorata basis and under certain conditions adjustments are made if the lights fail to burn during night hours.

Schedule G Co-operative Resale Rates

Available to municipal plants and private companies whose territory adjoins the territory served by the

Reading Department, for distribution to such of their customers as cannot be served from their existing distribution lines, provided the Reading Department has available facilities for furnishing this service.

5¢ per KWH for the first 25 KWH per month
3¢ per KWH for all over 25 KWH per month

This schedule carries a minimum charge of $9.00 per year per meter, payable monthly and adjusted annually on the last billing date in the calendar year.

With the exception of service under Schedule F, a discount of 10 per cent is allowed, except on minimum bills, if payments are made not later than 15 days from the date of the bill, although no discount is allowed when payments for previous months are due.

Schedules D, E, and G for Commercial Power, Primary Power and Co-operative Resale respectively are also in effect in Wilmington, North Reading, and Lynnfield. The other schedules applying in these Towns vary from those applicable in Reading as indicated below.

Residence Rates

For the first 50 kilowatt hours used per month the charge is 7 cents per kilowatt hour.

Commercial Lighting Rates

The first 100 kilowatt hours used per month are billed at 7 cents per kilowatt hour.

Miscellaneous Commercial Rates

7 cents per kilowatt hour is charged for the first 25 kilowatt hours used per month.

Street Lighting Rates

Rating of Lamp	Yearly Rates	
	A	B
60 C.P. Series or 50 Watt Multiple	$13.50	$15.00
100 C.P. Series or 75 Watt Multiple	19.00	21.00
250 C.P. Series or 150 Watt Multiple	32.00	36.00
400 C.P. Series or 200 Watt Multiple	42.00	48.00
600 C.P. Series or 300 Watt Multiple	54.00	60.00
1000 C.P. Series or 500 Watt Multiple	65.00	72.00

A---Service until 1 a.m.
B---Service all night.

Summary of the Present Situation

A summary of the present situation as shown by the report of the Reading Municipal Light Board for the year ended December 1934, indicates that the total plant investment is $532,006.43: that 7,516,389 kilowatt hours of current were purchased from the Edison Electric Illuminating Company of Boston at an average cost of 1.121 cents; that 86.6 per cent of the customers served have residence service; that 6,522,197 kilowatt hours of current were sold; and that the total gross income was $264,735.32.

It is also true that the generating plant is in good repair and could be put into use upon reasonable notice, although its capacity is not sufficient to provide all the

current needed to meet the existing demand.

A comparison of the present rate schedule with those of other municipal electric light companies as well as with those of privately owned electric light companies, shows that all classes of customers served by the Reading Municipal Light Board are buying current at favorable rates. Furthermore a comparison with previous rate schedules of the Reading company indicates that the present rates are the lowest in the history of the plant which has been in existance for a little over forty years.

CHAPTER IV

OUTLOOK FOR FUTURE CONSUMPTION OF CURRENT

In order to determine whether it seems advisable for the Reading Municipal Light Board to continue the purchase of current at wholesale or whether it would appear to be better for them to generate the current locally, it will be necessary to estimate the probable demand during the next few years. It will then be possible to compare the estimated cost of generation with the estimated cost of purchase. While there are other factors involved, which should be considered before deciding whether current should be generated or purchased, the comparative cost of delivering the current at the switchboard has an important bearing upon the final conclusion.

What the future will bring is always somewhat problematical, but it seems particularly difficult to forecast the future demand for current with any degree of certainty, because there are so many varying factors to be considered. While an analysis of certain data throws some light on the matter it will be necessary to rely to a large extent, upon an intimate knowlege of the community.

Type of Community

The four towns served by the Reading Municipal Light

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Type of Community

The four towns served by the Reading Municipal Light

Board have always been residential rather than industrial although it was only a relatively few years ago that Wilmington, North Reading, and Lynnfield were looked upon as farming communities. Today, however, they should probably be called residential rather than agricultural towns. In any event, they are not now, nor ever have been, industrial communities.

There have, of course, been a few small industries in these towns, but the number has been gradually decreasing during the past ten years. For example, there used to be two wagon factories and a shoe shop in North Reading. One of the wagon factories burned and was not rebuilt, the other is now manufacturing truck bodies to order on a very small scale. The shoe factory is still operating.

There have never been any industrial plants in either Wilmington or Lynnfield large enough to be considered in this study.

While Reading has always been primarily a residential community, the few industries that were in existance six or eight years ago have decreased in number and the production of several that are still in existance has declined. For the past five years two organ pipe factories have been practically idle. About three years ago a box factory was destroyed by fire and has not been rebuilt. Within the past few weeks the Reading Rubber Manufactur-

ing Company and the Sanford Mills have consolidated. For some time these have been the largest industries in Reading.

No doubt the present situation, as far as it relates to industries in the Town of Reading, is due in part to the poor business conditions existing during the last four or five years. It seems certain, however, that anyone familiar with the local situation, would expect the town to become less industrial rather than more so.

The following article which was published in the "Reading Chronicle" under the date of February 21, 1936 is of interest.

Why People Move to Reading

"The following information, collected by the Reading Executive Survey, W.P.A. Project No. 4159, was given to investigators who contacted most of the families that have moved to Reading during the past ten years. It gives their chief reasons why they moved to Reading:

Residential, non-congested type of community	235
Transportation facilities	206
Nearness to country and geographical advantages	176
Public health conditions	176
Found work here	120
Recommendations of friends	117
Reputation of educational institutions	65
Type of people	53
Reputation of good parks and play areas	40
Price of real estate	14

Low taxes and rents........................	13
Reputation as to good town government....	10
Reputation as to clubs and organizations.	4

"The list shows the chief reason; most people also combined several reasons. These facts were taken into consideration in the preparation and emphasis of the copy in the new Reading Publicity Booklet."

The expectation that Reading will become even less industrial in the future is due, in part, to the trend during the last quarter of a century and also to the fact that there is very little land available for industrial purposes. Most of the vacant land in Reading is more suited to residential building than to plant construction and furthermore, the zoning laws limit the available locations for industrial purposes.

About the same situation exists in Wilmington, North Reading and Lynnfield, although the zoning laws in these Towns are not so much of a deterrent to industrial building. The lack of railroad facilities in North Reading and Lynnfield, however, is a further reason why these towns are not likely to become more industrialized. The railroad facilities in Wilmington are adequate but there is very little land suitable for industrial sites in close proximity to the railroad.

Commercial Service

All in all it seems quite apparent, to one familiar

with the communities served by the Reading Municipal Light Board, that the likelihood of any substantial increase in the sale of current for industrial purposes in the near future is very remote. In fact, the sale of current for "commercial power" has steadily declined since 1930. A comparison of the number of kilowatt hours sold for such use in 1929 with the number of kilowatt hours sold for the same purpose in 1924 shows a decrease of about 44.32 per cent.

The sale for all commercial purposes during this same period has, however, increased by a little more than one thousand kilowatt hours. This increase is not significant when compared with the increase of the total sales of current for all purposes, and is accounted for by the sale of current for commercial lighting and miscellaneous purposes.

Inasmuch as the classification of commercial lighting includes current for lighting in the retail stores, it is probable that the sales to this class of customers will increase in the future for, as will be pointed out later, there is evidence that the population of the four Towns served by the Reading Municipal Light Board is likely to increase substantially within the next few years. This will naturally bring about an increase in the number of retail stores.

Even if this prophecy proves to be correct, the increase in the sale of current for commercial use will probably not be significant in the immediate future, even when allowance is made for improved business conditions.

Residential Service

The current sold for residential use has been more than twice the amount sold for commercial use in recent years, so it would appear that the probable development in the sale of current to residential customers is far more important than the future sales to commercial users.

The sales to residential customers have steadily increased since 1929 until in 1934 they were more than 53 per cent ahead of the sales in 1929. This increase might indicate the future trend or on the other hand it might indicate that the saturation point had virtually been reached and that future increases in the sale of current for residential use would probably decline. There are, of course, several factors involved that need to be considered before making a forecast as to the future sales to residential customers.

First, should be considered the potential number of new customers. As shown by the chart in chapter three, entitled, "Classification of Customers as of December 31, 1934" the number of residential customers in Reading were

2646; in Lynnfield 408; in North Reading 700; and in Wilmington 1120. Time has not permitted a survey to determine the maximum number of possible customers in these four towns, but the relation between their total population and the present number of customers indicates that the potential number of new customers is quite small. This fact is further borne out by observation of the houses at night and by the wires leading to the houses even in the poorer sections, and in the more remote sections where electricity would be less likely to be used. While there are undoubtedly some potential new customers at present in the communities, the greatest increase in residential connections will probably come as a result of new families moving into the towns served by the Reading Municipal Light Board.

As further evidence to support this conclusion the following table is included to show the total number of customers served from 1920 to 1934 as well as the yearly increase in the number of customers. An analysis of these figures shows that the number of customers served in 1934 is about 18 per cent greater than the number served in 1926, and approximately 8 per cent greater than the number served in 1929, and furthermore that the percentage of increase has in general been steadily decreasing since 1925. In fact the year 1934 showed a

decrease as compared with 1933, although the percent of decrease is so small as to be of little significance.

These facts do, however, support the contention that there is very little reason to expect a future increase in the number of customers served by the Reading Municipal Light Board except as a result of development throughout the community.

Number of Customers Served By Reading Municipal Light Plant*

Year	Number of Customers	Increase Over Previous Year
1920	2,617	
1921	2,939	322
1922	3,234	295
1923	3,666	432
1924	4,058	392
1925	4,472	394
1926	4,786	314
1927	5,017	231
1928	5,085	68
1929	5,221	136
1930	5,380	159
1931	5,487	107
1932	5,547	60
1933	5,652	105
1934	5,626	decrease 26

As would be expected, the building of new homes has been somewhat retarded during the past few years, but recently the activity in home construction has shown a marked increase. This is particularly true in Reading, where there are at the present time three new developments in which a total of fifteen houses are in the process of

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*Reading Municipal Light Board Annual Report-1934-p. 258.

construction, and others are to be built very shortly. In addition to the houses being built in these developments, there are a number of other houses just recently completed or yet to be finished. In fact, there has been so much residential building in Reading during the last year that it has been commented on several times in special articles in the Boston papers.

In the belief that the present situation is indicative of the future, a very definite campaign is well under way, sponsored by several of the more active organizations in the town, to acquaint prospective home owners with the advantages of residing in Reading. This is more than a mere advertising campaign to benefit the local real estate agents.

The purpose of this campaign is well stated in the following editorial that appeared in the Boston Herald of February 21, 1936.

"AN IDEAL HOME TOWN

What the Chamber of Commerce with industries to promote, and the Real Estate Association with land to sell, have done a thousand times, the town of Reading itself is now doing, and doing well. Why should not a municipality so proud of what it is and what it intends to be tell the world about itself?

The handsome booklet now issued by the selectmen of Reading advertises that suburban town as a community of homes. This is said to be the very first time a town has used this method of publicity. What also is at least rare, this town is seeking most of all to attract new residents, not to sell factory sites or subsidize new business."

The majority of citizens interested in the welfare of the town believe very sincerely that there is bound to be an even greater influx of families and are anxious to attract the type of families that will enhance the standing of the community. When those who are in a position to judge hold this belief and are willing to back up their idea with dollars, their opinions can not be taken lightly.

While it would be quite easy to show other reasons why it is logical to expect a substantial increase in the number of families in the four communities served by the Reading Municipal Light Board, the foregoing discussion will suffice to justify the opinion. Such an increase in the number of families will, of course, mean an increase in the amount of current sold to residential customers. Just what this will mean in terms of kilowatt hours of current is rather hard to determine with any certainty.

Potential Sales To Present Customers

Another factor which should be considered in estimating the future increase in sales to residential customers is the probable increase in the amount of current that the present customers will use. To a large extent this increase will come from a more general use of electrical appliances. This will be affected, not only by the financial condition of the customers, but also by the future prices of appliances. The desire for increased business on the part of the manufacturers of electrical appliances will be likely to place these products more easily within reach of the families of moderate incomes. From talking with the salesmen connected with the local stores that sell electrical appliances it is apparent that there is, even at present prices, a large potential demand, especially for electrial refrigerators. These same representatives of the local stores say that there are many families in the community that will buy electrical refrigerators as soon as they feel that they are financially able to do so, and furthermore that the same condition exists with respect to other types of appliances, but that it is more marked in the field of electrical refrigeration.

On the bases of past experience, it is fair to conclude that the sale of current for residential use will

increase if the rates are reduced. On the other hand the increased sale of current is a factor which will have strong influence in the reduction of rates. Lower rates will increase sales and increased sales will tend to lower rates. Until the subject is further developed it is not possible to tell whether a reduction can reasonably be expected in the near future, but a conclusion along this line will be reached later.

An increased amount of current can be sold to existing customers with very little capital outlay and therefore, any increase in the average number of kilowatt hours sold per residence meter, is perhaps more desirable than an increase which comes about from new installations.

In order to show a comparison of the number of customers and the average number of kilowatt hours sold per residence meter the following table is included:

Kilowatt Hours Sold per Residence Meter, Reading Municipal Light Board.*

Year	KWH Sold	Per Centage Increase
1929	544	
1930	611	12.31
1931	658	7.69
1932	682	3.64
1933	726	6.45
1934	758.5	4.47

As previously stated the number of customers in 1934 was 8 per cent greater than in 1929, but the above figures

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*Annual Reports of Reading Municipal Light Board.

show that the average number of kilowatt hours per residence meter sold in 1934 was about 39 per cent greater than in 1929. While the percentage of increase has been fluctuating from year to year, there does not seem to be any indication that the average sales have reached their maximum.

Maximum Load

While the average number of kilowatt hours sold per residence meter and the number of customers served has a definite effect upon the total number of kilowatt hours sold during any given period, the maximum demand at any one time is of more significance in determining the size of a generating plant adequate to meet the demand of the Reading plant in the immediate future.

The following table indicates the maximum load carried by the system in each year from 1925 to 1934 together with the yearly percentage of increase:

Maximum Load Carried by The Reading Municipal Light Plant*

Year	K.W.H.	Percentage Increase
1925	1280	
1926	1340	4.60
1927	1590	18.65
1928	1600	.60
1929	2048	28.00
1930	2190	6.90
1931	2250	2.70
1932	2500	11.00
1933	2250	decrease 10.00
1934	2500	11.00

*Annual Reports of Reading Municipal Light Boards.

With the exception of 1933 there has been an increase in the maximum load carried each year during the ten years for which the figures are given, although it is true that the maximum load in 1934 was no greater than in 1932. The possible maximum load of the present generating plant is about 1500 kilowatt hours, so it is apparent, that if the Reading Municipal Light Board were to enlarge its generating plant sufficiently to supply current enough to meet the existing demand and to allow any margin for future increase, it would be necessary to at least double the present production capacity. A further analysis of this aspect of the situation will be made in the next chapter.

Summary

A summary of the various factors affecting the outlook for future consumption of current by the customers served by the Reading Municipal Light Board indicates the following:

1. That there is no reason to believe that there will be any significant increase in the amount of current sold for industrial purposes, but that on the other hand, there is no evidence pointing to a decrease.

2. That the largest increase in consumption will come from customers having residential service. This increase will be largely due to installations resulting from new

With the exception of 1923 there has been an increase in the maximum load carried each year during the ten years for which the figures are given, although it is true that the maximum load in 1924 was no greater than in 1922. The possible maximum load of the present generating plant is about 1500 kilowatt hours, so it is apparent, that if the Reading Municipal Light Board were to enlarge its generating plant sufficiently to supply current enough to meet the existing demand and to allow any margin for future increase, it would be necessary to at least double the present production capacity. A further analysis of this aspect of the situation will be made in the next chapter.

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1. That there is no reason to believe that there will be any significant increase in the amount of current sold for industrial purposes, but that on the other hand, there is no evidence pointing to a decrease.

2. That the largest increase in consumption will come from customers having residential service. This increase will be largely due to installations resulting from the

construction rather than connections with existing residences, and to an increase in the average number of kilowatt hours used per residence meter.

3. That, if it is possible to further decrease the rates, the total consumption of current will be greater than under the existing rates.

CHAPTER V

CAPACITY AND COST OF PLANT ADEQUATE TO MEET PRESENT AND FUTURE DEMAND

If the Reading Municipal Light Board were to generate its own current rather than to continue the purchase of current from some outside source, several changes in the present power plant would be necessary.

It will be recalled that the present generating plant has not been enlarged nor modernized since the Light Board began to purchase current from The Edison Electrical Illuminating Company of Boston in 1926, although the plant has been kept in operating condition. Its maximum capacity, as shown by recent tests made by the General Electric Company, is 1600 kilowatts, which, of course, is not sufficient to care for the present peak load. Furthermore, the plant is operated by steam power.

In 1925 the maximum load was 1280 kilowatt hours and it steadily increased until it reached 2500 in 1932. In 1933 the peak load recorded was 2250 kilowatt hours, but in 1934 it again reached 2500. In 1935 it dropped to 2450 kilowatt hours. From an analysis of these figures it appears uncertain as to whether the peak load has reached its limit

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In 1929 the maximum load was 1800 kilowatt hours and it steadily increased until it reached 2500 in 1932. In 1933 the peak load recorded was 2250 kilowatt hours, but in 1934 it again reached 2500. In 1935 it dropped to 2450 kilowatt hours. From an analysis of these figures it appears uncertain as to whether the peak load has reached its limit under present conditions or whether it will show a still further increase even under normal growth. Inasmuch as 2500 kilowatt hours represents the largest load that has ever been recorded, it is a safe basis to use in determining the plant capacity needed to meet the demand in the immediate future.

On this basis it would seem that the present plant should be enlarged to a capacity of at least 3000 kilowatt hours if the current is to be generated rather than purchased. This would allow a margin of 20 per cent which should be sufficient, especially in view of the fact that it does not seem likely that the maximum load will increase very much in the next few years. To enlarge the plant to a capacity of 3000 kilowatt hours would virtually mean doubling its present capacity. This would not only require more generators, but would necessitate the enlargement of the steam plant as well, if the new generators were to be operated by steam power.

Before deciding whether the new generators, that would have to be provided, should be driven by steam power or by diesel engines, it will be well to determine the number and capacity of these units. In order to do this on any satisfactory basis it will be necessary to study twenty-four hour load charts, showing the load carried during the maximum day, the minimum day, and during a day about half under present conditions or whether it will show a still further increase even under normal growth. Inasmuch as 2500 kilowatt hours represents the largest load that has ever been recorded, it is a safe basis to use in determining the plant capacity needed to meet the demand in the immediate future.

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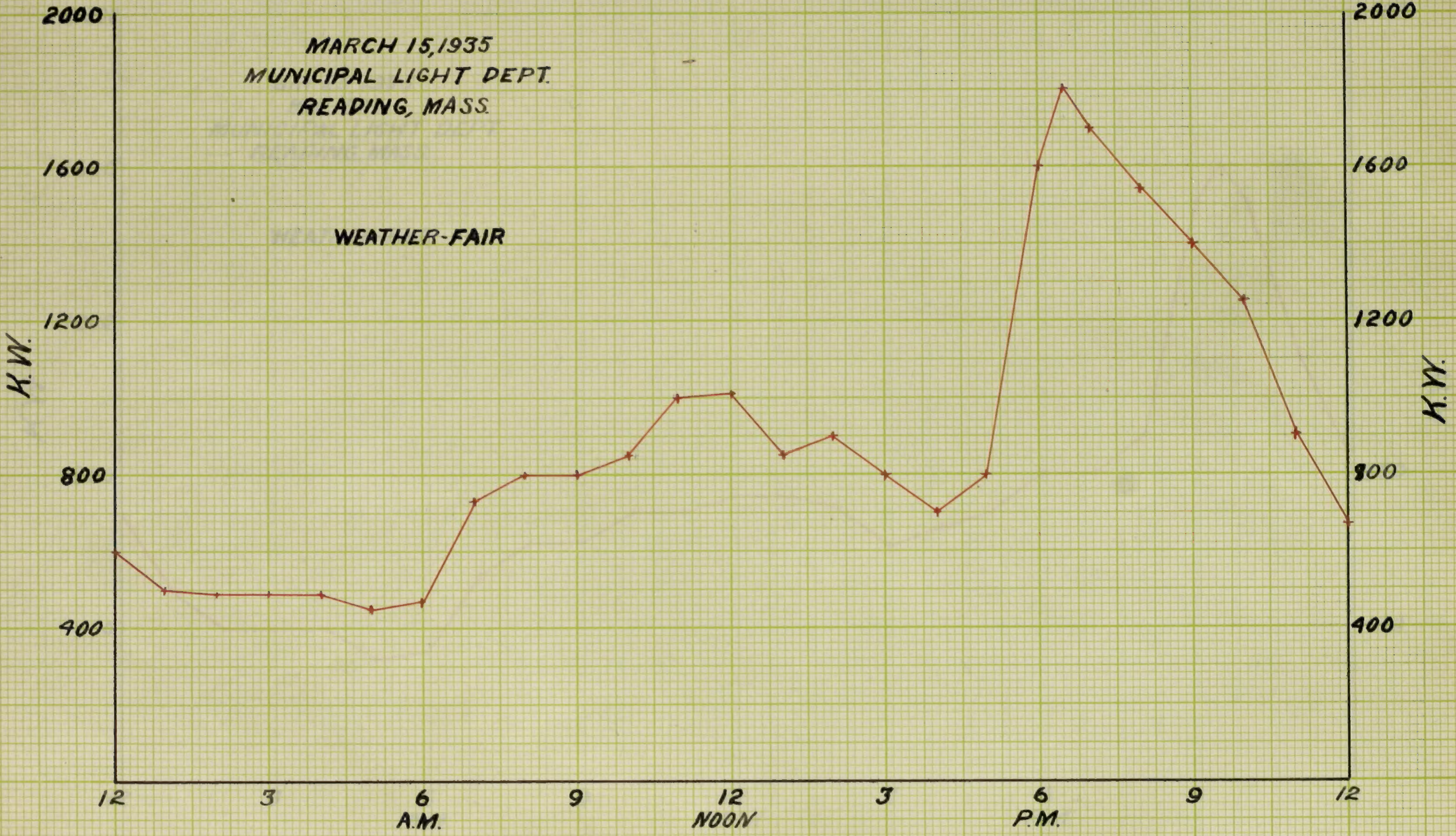
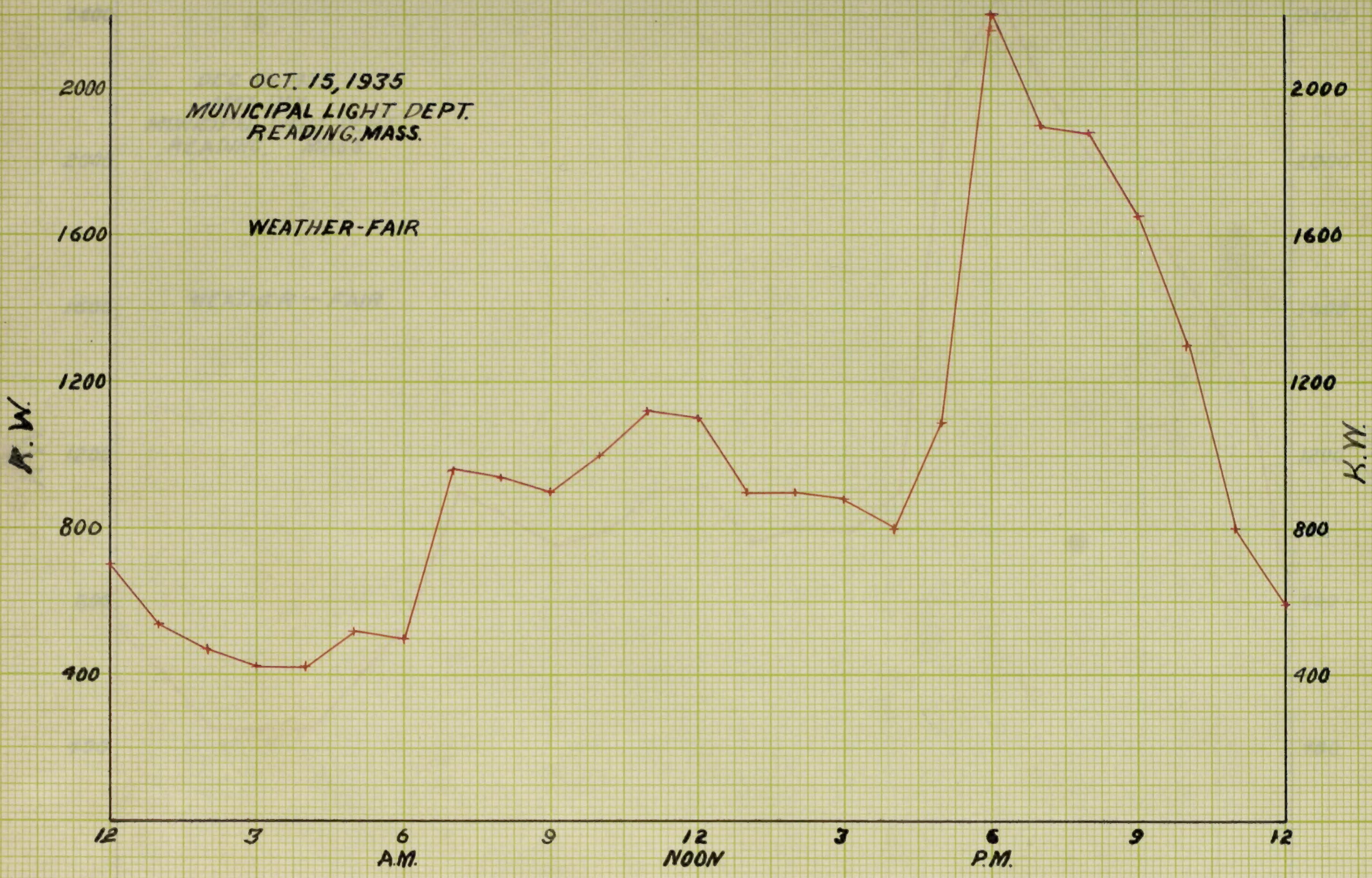

MARCH 15,1935
MUNICIPAL LIGHT DEPT.
READING, MASS.
WEATHER-FAIR
K.W.
2000
1600
1200
800
400
K.W.
2000
1600
1200
800
400
12
3
6
A.M.
9
12
NOON
3
6
P.M.
9
12

P.R.N. 3-12-36


MAY 25, 1935
MIN. DAY
MUNICIPAL LIGHT DEPT.
READING, MASS.

WEATHER-FAIR

P.R.N. 3-12-36


OCT. 15, 1935
MUNICIPAL LIGHT DEPT.
READING, MASS.
WEATHER-FAIR
K.W.
2000
1600
1200
800
400
K.W.
2000
1600
1200
800
400
12
3
6
A.M.
9
12
NOON
3
6
P.M.
9
12


DEC. 20, 1935
MAX. DAY
MUNICIPAL LIGHT DEPT.
READING, MASS.
WEATHER — FAIR
K.W.
2400
2000
1600
1200
800
400
K.W.
2400
2000
1600
1200
800
400
12
3
6
A.M.
9
12
NOON
3
6
P.M.
9
12
P.R.N. 3-12-36

way between the maximum and the minimum.

In order to make the discussion on this point clear, charts have been included which show the load carried during the following days in 1935: March 15, May 25, October 15, and December 20. The originals of these charts were prepared at the office of the Reading Municipal Light Board.

A careful study of these charts reveals many interesting points, but perhaps the most noticeable is the contrast with typical load charts for companies selling a larger percentage of energy for commercial use.

It appears from these charts that the load of the Reading plant from midnight until six o'clock in the morning does not exceed 800 kilowatts at any time during the year. The summer load is also 800 or less except for about three hours a day around the time that the peak load is reached. In fact, the load does not go much over 1000 kilowatts at any season of the year except for a few hours a day. The average load is about 1000 kilowatts which gives a load factor of approximately 40 per cent. This load factor is computed by relating the average load to the peak.

The foregoing facts furnish a satisfactory basis for deciding upon the number and capacity of the generating units which should be provided if the Reading company were

to generate its own current. The ideal arrangement is one in which the peak load can be carried, even if the largest unit is not in operation, and where the average loads at the different seasons of the year can be carried without generating current greatly in excess of the demand. Such arrangement provides a margin of safety and at the same time allows economical operation of the plant. While this ideal cannot be fully realized, it should be kept in mind when deciding upon the number and capacity of the units to be provided.

There are three possibilities that should be considered in connection with any proposed enlargement of the Reading plant.

It would be possible to use the existing generating units and to install additional units which would be operated by steam turbines. As has already been stated this would also require the enlargement of the steam power plant.

Another plan that could be used would be to suppliment the present equipment by diesel driven units, with the expectation that the present equipment would ultimately be replaced by diesel units.

Still another possibility would be to scrap all of the generating equipment now in the plant and install up-to-date equipment throughout. If this were done, either

steam power or diesel engines might be used.

The writer has discussed these different possibilities with an engineer connected with one of the better known companies that manufacture and sell diesel engines* and also with a representative of a very well known company** that manufactures and sells generating units and turbines. In fact, the representative of the latter company is very familiar with the situation at the Reading plant. While both of these men were quite willing to discuss the whole situation in detail, neither of them wanted to be quoted. This was due largely to the fact that they could not give accurate information without an actual survey, which of course they could not be expected to undertake without being paid for it. The estimates that they were able to make are undoubtedly sufficient for the purposes of this study, but it is not surprising that they did not care to have them recorded as coming from their respective companies.

These two engineers were not in agreement as to which of the possible plans outlined above would be the most feasible. This is probably because they represent companies that are to some extent competitive. The writer does not pretend to have sufficient engineering knowledge to determine the matter himself, so it has been decided to accept the opinion of the manager of the Reading

* Company A
**Company B

light plant, who is recognized as an authority in the management of municipal electric plants. It is his belief that the most economical thing to do, in the long run, would be to install up-to-date equipment throughout the plant and to use diesel engines, rather than to operate with steam power. To support this opinion he points to the fact that this was done at Hudson, Massachusetts with good results. In fact the Hudson plant seems to be looked upon as a model plant by a number of men in the electric industry.

Assuming, then, that if current were to be generated at the Reading plant, modern diesel equipment would be installed, it still has to be determined how many generating units would be needed and what their capacity should be.

There seems to be general agreement among those interviewed in this connection, that the best combination would be to install two generating units with a capacity of 1000 kilowatts each and two units capable of producing 500 kilowatts. As it would not be necessary to operate any of these units at full capacity at any one time, it would be possible with this combination to generate current in blocks of 250 kilowatts, ranging from 250 to 3000 kilowatts. Under these conditions, production would not be greatly in excess of the demand, regardless of the variations in the load.

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Assuming, then, that if current were to be generated at the Wenning plant, modern diesel equipment would be installed, it still has to be determined how many generating units would be needed and what their capacity should be.

There seems to be general agreement among those interviewed in this connection, that the best combination would be to install two generating units with a capacity of 1000 kilowatts each and two units capable of producing 500 kilowatts. As it would not be necessary to operate any of these units at full capacity at any one time, it would be possible with this combination to generate current in blocks of 500 kilowatts, ranging from 500 to 3000 kilowatts. Under these conditions, production would not be greatly in excess of the demand, regardless of the variations in the load.

Of course, if one of the larger units should break down, it would not be possible to generate more than 2000 kilowatts. Assuming the peak load to be 2500, this would leave a deficiency of 500 kilowatts. The load charts already referred to, indicate that the demand exceeds 2000 kilowatts for only a few hours during the year. Because of this fact and also because it is proposed to install entirely new equipment, this theoretical deficiency does not seem to present a practical problem that would have to be met in the immediate future. There would be ample opportunity to make ordinary repairs at seasons when the demand is low and some emergency repairs could be made off the peak.

In estimating the cost of enlarging and operating the plant the combination of four generating units, suggested above, will be assumed.

While the cost of generating equipment depends somewhat upon the size of the units used, and the conditions existing at the place of installation, it is usual to allow $100 per kilowatt hour capacity when estimating the cost of installing equipment for a diesel plant. This amount is considered to be ample at the present time and a closer estimate is not likely, unless a complete engineering report is available. It has not been possible to have such a report made in connection with this study.

If the standard figure of $100 per kilowatt hour is adopted, the estimated cost of generating equipment sufficient to suit the needs of the Reading plant on the basis explained above would amount to $300,000.

In order to install new diesel equipment some alterations in the interior of the present building would be necessary. A fair estimate of the cost of such alterations would be $10,000, making a total estimated cost of enlarging the generating plant $310,000.

CHAPTER VI

OPERATING COSTS OF PLANT ADEQUATE TO MEET PRESENT AND FUTURE DEMAND

The estimated costs of operating a generating plant with new diesel equipment, as described in the previous chapter, have been worked out on the basis of information furnished by a diesel engineer associated with one of the leading manufacturers* of diesel equipment. The items which have been included in the operating costs are those designated to be so classified by the Public Utility Commission of Massachusetts.

Labor

Inasmuch as a diesel generating plant requires very little manual labor, the proposed Reading plant could be operated by six men working in three eight hour shifts of two men each. In view of wages paid in Reading at the present time for comparable work, it is estimated that men with the required ability could be hired for $35.00 per week. This would bring the annual cost of employing six men to $10,920, but provision should be made for vacations and loss of time due to illness, etc. If these

*Company A.

factors are considered the estimated annual labor cost would be $12,000.

Fuel

The cost of fuel consumed by diesel generating units is estimated on the basis of the number of kilowatt hours generated, consideration being given to whether or not the units are operated at full capacity. If a 1,000 kilowatt diesel generating unit is operated at full capacity an allowance of 1 gallon of fuel oil is made for every 13.4 kilowatt hours generated. At three-fourths capacity 13 kilowatt hours can be generated for each gallon of oil consumed, whereas only 11.6 kilowatt hours of current can be generated per each gallon of oil consumed if the unit is operated at half capacity.

From the discussion in Chapter V, it is apparent that the proposed generating units would not be operated at full capacity all of the time, but on the other hand there is no satisfactory method of determining the number of kilowatt hours that would be generated while the units were operated at different percentages of capacity. In order to recognize the variations in fuel consumption it has been assumed that, on the average, 12.5 kilowatt hours could be generated per each gallon of fuel oil consumed.

On the basis of the average per cent of increase in

the amount of current purchased annually for the five years ending December 31, 1934,* it is estimated that the annual production for the next three years would be 8,000,000 kilowatt hours. Thus the fuel consumption would be about 640,000 gallons per year. At the present price for fuel oil, 4½ cents per gallon, the annual cost would be $27,200. In order to be conservative, a round figure of $30,000 has been used as the estimated cost of fuel.

Lubricants

The cost of lubrication is estimated by allowing one gallon of lubricating oil for every 2,000 kilowatt hours generated. At the present price of 55 cents a gallon, the estimated annual cost of lubricants amounts to $2200 on the basis of a total production of 8,000,000 kilowatt hours.

Maintenance

The maintenance costs of diesel generating units are sometimes estimated on the basis of horsepower years and sometimes on the basis of the number of kilowatt hours generated. It seems to the writer that the maintenance costs are more likely to be in proportion to the number of kilowatt hours generated, than to the horsepower of the engines. The maintenance costs have, therefore,

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*Annual Reports of Reading Municipal Light Board.

been estimated by allowing eight-tenths of a mill per kilowatt hour. On this basis the estimated maintenance cost is $6400 annually.

Summary of Generating Costs

The estimated generating costs are as follows:

Labor	$12,000
Fuel	30,000
Lubricants	2,200
Maintenance	6,400
Miscellaneous	5,000
Total	$55,600

If the generating plant were enlarged, the annual depreciation charges would be increased and there would be bond interest and bond amortization to be considered in addition to the production costs shown above. In estimating costs for an industrial concern, the depreciation and possibly the bond interest and amortization would be included in the cost of production. This is not done by electric companies operating under the regulation of the Massachusetts Public Utilities Commission, and therefore, these items will be taken into consideration later.

Transmission, Distributing and General Operating Expenses

With the exception of depreciation, the operating expenses which do not have to do with the cost of delivering

the current to the switchboard, will be the same if the current is generated at the Reading plant as they will be if the current is purchased, for quite obviously, the cost of production has no effect upon the distributing and general operating expenses.

While an increase in the amount of energy sold will cause some increase in these expenses, it will probably be relatively small during the next few years, because, as has already been shown, greater consumption of energy will result quite largely from an increase in the number of kilowatt hours used per residence meter. Under such conditions the distributing and general operating expenses will not increase in proportion to sales.

In view of these facts it has been decided to estimate these expenses for the immediate future on the basis of the average for the five years ending December 31, 1934 with some adjustments which quite apparently should be made in certain items. If it were necessary to attempt to estimate each item of expense with a high degree of accuracy, a more elaborate method of forecasting might be advisable. In this study, however, the total of the various items is all that is of any particular significance and it is believed that the estimates which have been made are reliable enough for present purposes.

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In detailing the estimated distributing and general operating expenses the terminology used in the annual reports of the Reading Municipal Light Board have been used so that comparisons can be made where desirable. Following are the estimated operating expenses, other than those which are chargeable to production costs.

Estimated Operating Expenses of The Reading Municipal Light Board.

Transmission and Distribution Expenses

Transformer Station and Substation Superintendence and Labor	$ 8,654.95
Transformer Station and Substation Supplies and Expenses	7,181.02
Operation of Transmission and Distribution Lines	22,043.52
Transmission and Distribution Supplies and Expenses	261.03
Inspecting and Testing Meters	1,814.56
Removing and Resetting Meters	2,065.99
Removing and Resetting Transformers	421.41
Maintenance of Transformer Station and Substation	3.49
Maintenance of Transmission and Distributing Lines	18,160.48
Maintenance Underground Conduits	126.68
Maintenance Underground Conductors	263.32
Maintenance of Consumers' Meters	400.62
Maintenance of Transformers	613.12
Total	$62,010.19

Utilization Expense

Operation of Municipal Street Lamps..........	$ 2,593.97
Maintenance of Municipal Street Lamps........	1,134.14
Maintenance of Consumers' Installations......	5,549.31
Municipal Street Lamps-Supplies and Expenses.	1,148.44
Total	$10,425.86

Commercial Expense

Commercial Salaries..........................	$10,614.36
Commercial Supplies and Expenses............	3,996.88
Total	$14,611.24

Miscellaneous and General Expenses

Salary of Manager............................	$ 5,677.66
Salary of General Office Clerks.............	5,222.02
General Office Supplies and Expenses........	1,942.28
General Office Rents........................	1,061.67
Insurance...................................	4,193.41
Accidents and Damages.......................	47.14
Store Expenses..............................	3,566.51
Transportation Expense......................	2,814.53
Inventory Adjustments.......................	2,386.93
Maintenance of General Structures..........	256.21
Depreciation................................	41,553.09
Miscellaneous General Expense...............	464.87
Total	$69,186.32

New Business Expense

New Business Salaries........................	$ 429.03
New Business Supplies, and Expenses...........	67.83
Advertising...................................	2,593.42
	$ 3,090.28

Estimated Non-Operating Expenses.

In addition to the operating expenses there are other costs, classed as non-operating expenses which have been estimated as follows:

Uncollectible Operating Revenue.............	$ 2,090.68
Taxes Assignable to Electric Operations......	2,059.26
Merchandise and Jobbing Loss.................	4,456.05
Rent Electrical Appliances...................	957.45
Interest on Bonds and Notes..................	10,563.56
Total	$20,127.00

With the exception of the interest on bonds and notes the above expenses have been estimated on the basis of the average for the five years ending December 31, 1934* as was done in estimating the operating expenses. In determining the interest charges it has been assumed that the $310,000 necessary to enlarge the generating plant would be raised by a twenty year serial bond issue, $15,500 worth of bonds to be retired each year. In view of interest rates on recent bond issues and the credit

*Annual Reports of Reading Municipal Light Board.

standing of the Town of Reading, it has been considered that these proposed bonds could be readily sold if they carried an interest rate of 3 per cent. This would mean that the average annual interest payments during the life of the bonds would be $4,882.50, but in order to arrive at a more accurate estimate of the interest costs in the immediate future, the average annual cost for the first five years that the bonds would be outstanding, has been used. On this basis, the average yearly interest payments would be $8,370.00 which, together with the average charges on the outstanding bonds and notes, would amount to a total of $10,563.56, the figure used above.

Summary

The estimated operating expenses already listed do not include any allowance for increased costs resulting from increased sales. While it does not seem necessary to make such an allowance in the detailed figures, an adjustment will be made in the total for the sake of conservatism.

The percentage of increase in the number of kilowatt hours sold per residence meter in 1930 was considerably above the average for the past several years. For this reason the average increase for the four years ending December 31, 1934 has been used in estimating future sales rather than a five year average that was used in estimating standing of the Town of Reading, it has been considered that these proposed bonds could be readily sold if they carried an interest rate of 3 per cent. This would mean that the average annual interest payments during the life of the bonds would be $4,662.50, but in order to arrive at a more accurate estimate of the interest costs in the immediate future, the average annual cost for the first five years that the bonds would be outstanding, has been used. On this basis, the average yearly interest payments would be $8,570.00 which, together with the average charges on the outstanding bonds and notes, would amount to a total of $10,563.56, the figure used above.

Summary

The estimated operating expenses already listed do not include any allowance for increased costs resulting from increased sales. While it does not seem necessary to make such an allowance in the detailed figures, an adjustment will be made in the total for the sake of conservatism.

The percentage of increase in the number of kilowatt hours sold per residence meter in 1950 was considerably above the average for the past several years. For this reason the average increase for the four years ending December 31, 1954 has been used in estimating future sales rather than a five year average that was used in estimating the operating expenses. On this basis, a normal increase in sales per residence meter is approximately 5.5 per cent. It has not been possible to find any authority to indicate the probable relationship between this increase and the increase in operating expenses, but in order to give reasonable recognition to this factor it has been decided to increase the estimated operating expenses by 1 per cent, resulting in a final amount of $160,917.12.

Following is a summary of the estimated generating, operating, and non-operating expenses on the assumption that current is to be generated at the Reading plant:

Generating Costs	$ 55,600.00
Operating Expenses	160,917.12
Non-Operating Expenses	15,670.95
Total	$232,188.07

CHAPTER VII

PROPOSED RATE SCHEDULES

General Principles of Rate Making

When rate schedules for a public utility are established, the general aim is to provide a gross revenue, sufficient to cover all operating and maintenance costs and in addition to allow a fair return on the investment used in serving the public. Usually an attempt is made to fix the rates for each customer, or each class of customers so that they will pay their proportionate share of the costs of rendering the service. This is particularly difficult because of the varying requirements of the customers. The requirements vary as to quantity, time when the service is used, regularity of use, distance from the plant, etc.

In allocating the various costs of rendering service to the different classes of customers the general principles of cost accounting should be followed. It is somewhat difficult to apply these principles exactly, however, because of the large amount of joint costs. This problem of joint costs is frequently encountered in other business, but it assumes considerable importance in the case of public utilities, because of the relatively large fixed costs.

Most public utilities are expected to be ready to serve all customers, at all times in accordance with their demands. The investment will therefore, be determined by the maximum demand of all the customers at any one time which is known as the peak load. The capacity of a company should not only be adequate to handle the peak load, but there should be a reserve capacity as a margin of safety in the event of a break down in equipment. The fluctuation in demand is of particular importance in establishing rates for the sale of electric current. This is due, partly, to the variation in demand during the different seasons of the year, but more especially to the fact that electricity cannot be stored and later used as a reserve supply, which can be done to some extent with gas or water. Even though the average load throughout the year is well below the maximum load, the fixed charges due to permanent investment have to be met, whether the facilities are used much or little. This also applies to a certain proportion of the operating expenses.

While it seems logical that the costs, which vary with the amount of service rendered, should be allocated to the customers, it does not follow that the fixed costs should be apportioned on the basis of the amount of service

used. The allocation of the fixed charges should be governed, not alone by the amount of service used, but also upon the time of use with reference to the peak load. It is generally considered that some inducement should be offered to encourage the use of facilities off the peak in an effort to bring the average load nearer the peak load.

Rates which are properly conceived should take into consideration three factors: service, commodity and demand.

The term "service" as used here, includes the separable costs directly chargeable to the customer, such as the cost of connection, reading meters, billing, etc.

The "commodity" charge should be determined by the number of units of the service used and is justified because many of the operating costs vary with the number of units produced. In some instances, however, the unit costs are in inverse proportion to the number of units produced and therefore the rates can be stepped down as the number of units used increase.

The "demand" factor refers to the cost of being ready to supply the maximum amount of service that the customer MIGHT use at any one time, whether or not he actually does use this amount. Furthermore, the time when this maximum might be used should be considered in relation to the time of the peak load.

Discussion of Possible Rate Structures

From the general principles of rate making outlined above, it is apparent that the charge for electric current should cover the cost of the customer's connection with the system, the cost of producing the energy used and the company's readiness to deliver up to a certain maximum. No matter how the rates are devised or in what terms the charges are stated, these costs must be included.

Straight Line Meter Rates

The, so called, straight line meter rate is based solely upon the energy consumed, and is a flat rate for every kilowatt hour used. While it has the doubtful advantage of extreme simplicity, it does not distribute the demand costs, nor the production costs, nor does it offer any inducement for increased use, either on or off the peak. In view of the general principles which should be given consideration when rates are established, there is little that can be said in favor of the straight line meter rate.

Block Meter Rates

Under a schedule of block meter rates a certain price is charged per kilowatt hour for the whole or any part of the first block of current used and a lower rate per

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Block Meter Rates

Under a schedule of block meter rates a certain price is charged per kilowatt hour for the whole or any part of the first block of current used and a lower rate per kilowatt hour is charged for the whole or part of each succeeding block.

The residence rates of the Reading Municipal Light Board may be used as an example of this type of rate, and are shown in Chapter III to be as follows:

6¢ per KWH for the first	50 KWH per month
3¢ per KWH for the next	150 KWH per month
2¢ per KWH for all over	200 KWH per month

Under this schedule the bill of a customer who used 250 kilowatt hours of energy in one month would be $8.50 computed as follows:

50 KWH @ 6¢	$3.00
150 KWH @ 3¢	4.50
50 KWH @ 2¢	1.00
250 KWH	$8.50

This would be an average rate of 3.4 cents per kilowatt hour.

While the block meter rates are actually based on the amount of energy used, the higher rate for the first block is intended to cover the customer charge, but they do not take into consideration the company's readiness to deliver the potential demand. They do, however, tend to encourage the use of increasing amounts of current, for the cost per kilowatt hour is proportionately less as the number used increases. For example, under the Reading rates shown above, 250 kilowatt hours per month would cost only two and one half times as much as 50 kilowatt hours per

month. The block meter rates may, of course, be supplemented by a demand or other charge.

Measured Demand Rates

Because of the importance of the demand factor as reflected in the capacity and operating costs of the plant, it should also be reflected in the rate schedules.

One method of giving the proper influence to this factor, is to measure the customer's maximum demand and fix the rates accordingly. This may be done by taking sample readings from regular meters, by the installation of demand meters, by determining the "connected load" in case of customers with small consumption, or by counting the number of outlets, as is sometimes done in connection with residential service. Any one of these methods of measuring the demand tends to reduce the influence of chance to a minimum, and to give proper weight to the demand factor when rates are set. It is not, however, usual to find rates based solely on demand.

Two Charge Demand Rates

The so called "two charge demand rates" include two separate charges, one for the number of kilowatt hours used and one based on the demand. Either one or both of these charges may be of the block form. These two charge rates

are frequently established for power users and are logical in view of the fundamental principles of rate making.

Three Charge Demand Rates

The three charge demand rates recognize the three main elements in the cost of electricity,- 1. the cost of connecting the customer to the system, 2. the cost of being ready to supply the maximum demand, and 3. the cost of the number of kilowatt hours of electricity used. This form of rate is more scientific than any of the other types discussed and therefore the most logical, but this method of fixing rates is often objected to because it produces schedules which are hard to understand and it is questionable whether the cost accounting methods, as used by electric companies are sufficiently developed to justify the use of the three charge demand rates.

Customer Charges

Another device which is sometimes used is known as a customer charge. If this is a pure service charge, it covers the cost of being ready to serve the customer, but does not permit the use of any current without the payment of an additional charge for the energy used. The service charge is especially objectionable to the customers because they do not understand the justification for it and cannot

see that they are receiving any service for the expenditure.

The minimum charge is another scheme which is often used in lieu of the service charge. All of the rates of the Reading company carry a minimum charge, with the exception of those for private street lighting. Such a charge is intended to cover the cost of connecting the customer to the system and also the cost of supplying a small number of kilowatt hours of energy. The minimum charge is generally more acceptable to the customers than the service charge for they feel that they are getting something for their money, and usually appreciate the justification for a minimum charge for the year. Furthermore, many customers use enough energy so that the total annual cost is in excess of the minimum charge and the existance of the charge does not cuase them any concern.

Conclusion as to the Most Suitable Rate Structure for Reading

While municipal light boards should follow the fundamental principles of rate making, as outlined above, they must of necessity consider the reaction of the consumers to the particular schedules established. It is desirable that rate schedules of municipally owned companies be so stated as to obtain the ultimate objectives of any good

rate structure, and at the same time, be easily understood by the customers and also appear fair to the residents of the community. Otherwise the voters are very apt to build up a prejudice against the officials in charge of the company, which may hinder sound management and possibly handicap the development of the plant. This is particularly true in a town, because it is necessary to have the credit of the town behind any bonds issued to raise funds to be used by the light board. If the customers are antagonized by the rate schedules they are likely to let this influence them when voting at Town Meeting and therefore oppose requests of the light board, on general principles. A reaction of this kind may easily prevent the issuing of bonds at a time when funds should be available for plant extensions or improvements.

The good will of the customers of a municipal light plant, is, therefore more important in some respects, than would be true of a privately owned electric company.

In view of the general reaction against the service charge it would appear that such a charge should not be used in the rate schedules of the Reading Municipal Light Board, although a minimum annual charge such as is now in use, is feasible. The present minimum charge has been in effect for several years without causing any appreciable amount of ill will among the customers. In fact, very few rate structure, and at the same time, be easily understood by the customers and also appear fair to the residents of the community. Otherwise the voters are very apt to build up a prejudice against the officials in charge of the company, which may hinder sound management and possibly handicap the development of the plant. This is particularly true in a town, because it is necessary to have the credit of the town behind any bonds issued to raise funds to be used by the light board. If the customers are antagonized by the rate schedules they are likely to let this influence them when voting at Town Meeting and therefore oppose requests of the light board, on general principles. A reaction of this kind may easily prevent the issuing of bonds at a time when funds should be available for plant extensions or improvements.

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The three charge demand rate is too complicated to be easily understood, especially by the majority of customers having residence service. Inasmuch as this class of customer supplies about 60 per cent of the gross income of the Reading company, it does not seem advisable to recommend the use of the three charge demand rate. There are also other objections which might be raised against the use of this type of rate, but the disadvantage already suggested is sufficient to eliminate it from serious consideration.

While a measured demand rate could probably be used for residence service without too much unfavorable reaction from the customers, it appears that the general advantages of this type of rate can be more easily obtained by other methods, which are less cumbersome to administer and more acceptable to the customers. This will be more fully explained in connection with the rate structure recommended.

The general advantages of a demand rate, that is,

the reflection of the demand factor in the rate schedule, seem to make the use of this type of rate feasible in fixing charges for the current sold for commercial power purposes. The objections raised against its use for residence service charges do not apply to the same degree in opposition to its use in connection with the sale of current to power-users.

If a demand rate is to be established for energy sold for commercial power by the Reading Municipal Light Board it would be better to adopy either a two charge demand rate or a measured demand rate. While it would be logical to argue in favor of either type of rate, the fact that the present rate is satisfactory, both from the point of view of the customer, and the Light Board, suggests the advisability of its continued use. As shown in Chapter III the present rate for commercial power is of the block meter type, and it is questionable whether a change would give greater satisfaction, even though a demand rate might, theoretically, be more logical.

It has been previously shown that any substantial increase in the sale of current will come from the sale of energy to residence customers and furthermore, that it will come quite largely from an increase in the average consumption per residence meter. As this is unquestionably true, and also as such an increase is the most the reflection of the demand factor in the rate schedule, seem to make the use of this type of rate feasible in fixing charges for the current sold for commercial power purposes. The objections raised against its use for residence service charges do not apply to the same degree in opposition to its use in connection with the sale of current to power-users.

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It has been previously shown that any substantial increase in the sale of current will come from the sale of energy to residence customers and furthermore, that it will come quite largely from an increase in the average consumption per residence meter. As this is unquestionably true, and also as such an increase is the most advantageous from the point of view of economical plant management, it is obvious that the rates for residence service should be so fixed as to encourage increased use of energy by present customers.

This would not be accomplished by the use of a straight line meter rate, which offers absolutely no inducement for increased use of energy. Furthermore, those who have been customers of the Reading company for any very great length of time will remember that this kind of a rate was once in existance and was not as satisfactory as the present residence schedule. The adoption of a straight line meter rate would certainly be looked upon, by many of the customers, as a backward step.

All in all, it seems that a block meter rate should be continued for residence service for the following reasons:

1. It is now giving satisfaction to the customers and plant management.
2. It is easily understood by the customers.
3. It offers an incentive for the increased use of energy.
4. It tends to recognize the demand factor, especially as a minimum charge is in effect.

It does not seem that any particular advantages would accrue from changing the rate schedules now in use by the

Reading Municipal Light Board. As has been previously pointed out, there are, however, certain advantages in their continued use.

Regardless of whether current is purchased or generated in the future no change is recommended in the present rate structures.

The existing schedules, as shown in Chapter III, are all of the block meter type, with the exception of the primary power rates and the street lighting rates. While the primary power rates are of the block type, they are based upon the number of hours use of the maximum kilowatt hour demand and the current is metered on the primary side of the transformers. The street lighting rates are based upon the size of the light used and in Wilmington, North Reading and Lynnfield, upon the additional factor of whether or not all night service is maintained.

All rates, except those for street lighting, carry a minimum charge.

While no change is recommended in the present rate structures, it is still to be concluded whether any changes should be made in the rates themselves. It is possible that this may depend upon whether the current is to be generated or purchased.

CHAPTER VIII

CONCLUSIONS

Although there are other factors to be considered, the deciding factor in determining whether or not the Reading Municipal Light Board should continue to purchase current or generate current at its own plant, is the comparative cost of energy to the consumer. The decision, therefore, depends quite largely upon the question of whether or not the generation of current would, in itself, make possible lower rates to any substantial number of customers. It is apparent that the sales of energy would not be affected by the generation of current, unless it brought about a saving which could be reflected in the rates.

For comparative purposes, the gross income can be considered to be the same, regardless of whether the current is purchased or generated, at the Reading plant. Any affect that a change in policy might have upon the rates can be shown by a comparison of the costs under each method of supplying current.

The estimated costs shown in Chapter VI computed on the assumed production of 8,000,000 kilowatt hours per year at the Reading plant are as follows:

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The estimated costs shown in Chapter VI computed on the assumed production of [illegible] kilowatt hours per year at the Reading plant are as follows:

Production Expense..........	$ 55,000.00
Operating Expense...........	160,917.12
Non-Operating Expense.......	20,127.00
Total	$236,644.12

These costs are shown below on the basis of the average estimated cost per kilowatt hour, expressed in cents.

Production Expense..............	.695
Operating Expense...............	2.011
Non-Operating Expense...........	.252
	2.958

The average total production cost per kilowatt hour for the five years ending December 31, 1934* was 1.278 cents. On this basis the total production cost would be $102,240 if 8,000,000 kilowatt hours were purchased at wholesale under the present rates. While it is possible that the rates of the Edison Electric Illuminating Company of Boston may change in the future, this comparison is being made on the assumption that the present rate schedule will be effective in the immediate future. The possibility of a change is to be considered later.

If the present policy of purchasing current were to be continued, the charges for depreciation would be

*Annual Reports of Reading Municipal Light Board.

lower than they would be if new equipment were installed in the generating plant. An adjustment for the item of depreciation included in the operating expenses shown above, results in an amount of $143,023.77 as the estimated operating expenses, if the current were purchased.

The non-operating expenses which have been estimated on the assumption that current would be generated, include an item for interest on bonds of approximately $8300. This expense would not be incurred if the current were purchased and, therefore, the estimated non-operating expenses would be $11,757.

If the policy of purchasing current were continued, the estimated costs would be as follows:

Production Expense	$102,240.00
Operating Expense	143,023.77
Non-Operating Expense	11,757.00
Total	$257,020.77

The average costs per kilowatt hour, expressed in cents would be:

Production Expense	1.278
Operating Expense	1.788
Non-Operating Expense	.149
Total	3.213

A comparison of these estimated costs indicates

that, if the generating plant were enlarged, the annual profit of the Reading Municipal Light Board would be $20,376.65 larger than the profit which would be realized if the current were purchased under the present rate schedule of the Edison company. This would amount to approximately 2.55 mills per kilowatt hour.

While it appears that a larger profit could be realized if the current were generated rather than purchased, it must be remembered that the bonds which would have to be issued to raise funds with which to enlarge the plant, would be retired from the earnings of the Light Board and not from general funds of the Town. On the basis used in making the above estimates, this would require $15,500 annually, which as far as the immediate future is concerned, would leave an extra amount of only $5,000 that could be transferred to surplus. This certainly would not be sufficient to permit any reduction in rates. The generation of current, as opposed to the present policy of purchasing, cannot be justified by the expectation that the cost of energy to the consumer would be lowered.

The interest of the tax payer is not involved, for the financial costs of borrowing any funds used by the Light Board as well as the amounts necessary to repay that, if the generating plant were enlarged, the annual profit of the Reading Municipal Light Board would be $20,578.50 larger than the profit which would be realized if the current were purchased under the present rate schedule of the Edison company. This would amount to approximately 2.30 mills per kilowatt hour.

While it appears that a larger profit would be realized if the current were generated rather than purchased, it must be remembered that the bonds which would have to be issued to raise funds with which to enlarge the plant, would be retired from the earnings of the Light Board and not from general funds of the Town. On the basis used in making the above estimates, this would require $14,300 annually, which as far as the immediate future is concerned, would leave an extra amount of only $5,000 that could be transferred to surplus. This certainly would not be sufficient to permit any reduction in rates. The generation of current, as opposed to the present policy of purchasing, cannot be justified by the expectation that the cost of energy to the consumer would be lowered.

The interest of the tax payer is not involved, for the financial costs of borrowing and funds were by the Light Board as well as the amounts necessary to carry any such loans, would be paid from the revenue of the Light Board and not from funds raised through taxes. Furthermore, it has been the custom for several years for the Light Board to turn over to the Town Treasurer an amount equal to the tax which would be paid by a privately owned company with the same investment. Presumably, this policy would continue whether current were purchased or generated.

As has been shown in the discussion of labor costs incidental to the operation of a diesel generating plant, the amount of labor needed is not sufficient to have any appreciable effect on the local employment situation.

The possible advantages and disadvantages of being dependant on outside sources for current is largely a matter of opinion. If an attitude of distrust toward the Edison company, such as was apparent in certain quarters at the time it was originally decided to purchase current, is adopted, then undoubtedly it would be concluded that the disadvantages of continued purchase would be sufficient to justify a change in policy. If, on the other hand, it is assumed that the Edison company will continue to look upon the Reading Municipal Light Board as a valued customer who deserves fair treatment in order that its business may be retained, then there seems to be no disadvantage in being dependent on an outside source for current. Further-

more, if it should develop at some future time that it would be more advantageous to discontinue the purchase of current at wholesale, new equipment could be installed in the generating plant at that time.

The writer is well acquainted with the temperament of the Reading voters, and the type of men usually elected to public office. He, therefore, finds it hard to believe that the Edison company or any other company will be likely to take undue advantage of the Town of Reading for any great length of time.

It seems that unfair treatment of a customer purchasing in the neighborhood of 8,000,000 kilowatt hours of current a year would indicate a very short-sighted business policy, which is not likely to be adopted by the Edison company.

The possibility of obtaining more favorable purchase rates in the future is somewhat a matter of conjecture. From general observation, the writer believes that a downward revision of wholesale rates for electric energy is quite probable within the next few years, but as a matter of fact this question is not possible of determination. It is safe to assume that, even if the present rates stay in force, the purchase of increasing amounts of current would reduce the cost per kilowatt more, if it should develop at some future time that it would be more advantageous to discontinue the purchase of current at wholesale, the equipment could be installed in the generating plant at that time.

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It seems that unfair treatment of a customer purchasing in the neighborhood of 4,000,000 kilowatt hours of current a year would indicate a very short-sighted business policy, which is not likely to be adopted by the Edison company.

The possibility of obtaining more favorable purchase rates in the future is somewhat a matter of conjecture. From general observation, the writer believes that a downward revision of wholesale rates for electric energy is quite probable within the next few years, but as a matter of fact this question is not possible of determination. It is safe to assume that, even if the present rates stay in force, the purchase of increasing amounts of current would reduce the cost per kilowatt hour. A reduction in the per kilowatt hour cost would also be shown if the current generated exceeded the amount estimated in the previous calculations. On the whole, then, it does not appear that this factor has any influence on the conclusions of this study.

In Chapter VII it was concluded that there was no reason to recommend a change in the present rate structure used by the Reading Municipal Board. It has just been shown that the generation of current would not, in itself, justify a reduction on rates in the immediate future. It is, therefore, recommended that the present rate schedule, as well as the rate structure, be continued in effect until such time as an increase in the amount of energy sold justifies lower rates.

As a result of this study it is finally concluded that whether the Reading Municipal Light Board should continue to purchase current or enlarge its plant and generate its own current is entirely a matter of policy as there are no tangible advantages of one plan as opposed to the other.

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